Praxair Equipment Yard
Tualatin, Oregon
Stormwater Report

Date: March 2021

Client:
Praxair Inc.
10450 SW Tualatin-Sherwood Road
Tualatin, OR, 97062

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AKS Job Number: 7784

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REGISTERED PROFESSIONAL ENGINEER
OREGON
CHARLES EDWARD GREGORY
RENEWS: JUNE 30, 2021

PRELIMINARY
NOT FOR
CONSTRUCTION

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1.0 Purpose of Report
The purpose of this report is to: analyze the effects the proposed development will have on the existing stormwater conveyance system; document the criteria, methodology, and informational sources used to design the proposed stormwater system; and present the results of the preliminary hydraulic analysis.

2.0 Project Location/Description
The proposed improvements are positioned south of the existing Praxair Distribution Center, located at 10450 SW Tualatin Sherwood Rd, Tualatin, Oregon 97062 (Tax Lot 1500, Washington County Tax Map 2S.1.23CC).

The proposed project consists of constructing a new equipment yard. The site improvements also include the construction of a stormwater facility and related underground utilities.

3.0 Regulatory Design Criteria
3.1 STORMWATER QUANTITY
Per Clean Water Services' (CWS) *Design and Construction Standards Manual for Sanitary Sewer and Surface Water Management (R&O 19-5, Amended by R&O 19-22)*, Section 4.02.1 Mitigation Requirement, the District or City shall determine which of the following techniques may be used:

a. *Construction of permanent on-site stormwater quantity detention facilities designed in accordance with this Chapter; or*

b. *Enlargement or improvement of the downstream conveyance system in accordance with this Chapter and Chapter 5; or*

c. *Payment of a Storm and Surface Water Management System Development Charge (SWM SDC), as provided in CWS Ordinance 28, which includes a water quantity component to meet these requirements. If district or City requires that an on-site detention facility be constructed, the development shall be eligible for a credit against SWM SDC fees, as provided in District Ordinance and Rules.*

Per Clean Water Services' (CWS) *Design and Construction Standards Manual for Sanitary Sewer and Surface Water Management (R&O 19-5, Amended by R&O 19-22)*, Section 4.02.2 Criteria for Requiring On-Site Detention for Conveyance Capacity, on-site detention is required when any of the following conditions exist:

a. *There is an identified downstream deficiency and the District or City determines that detention rather than conveyance system enlargement is the more effective solution.*

b. *There is an identified regional detention site within the boundary of the development.*

c. *Water quantity facilities are required by District-adopted watershed management plans or subbasin master plans or District- approved subbasin strategy.*

3.2 HYDROMODIFICATION

Per Clean Water Services' (CWS) *Design and Construction Standards Manual for Sanitary Sewer and Surface Water Management (R&O 19-5, Amended by R&O 19-22)*, Section 4.03.1 Hydromodification Approach Requirements, the implementation or funding of techniques to reduce impacts to the downstream receiving water body is required when a new development, or other activities, creates or modifies 1,000 square feet or more of impervious surfaces or increases the amount or rate of surface water leaving the site. The following techniques can be implemented or funding to reduce impacts to the downstream receiving water body:

a. Construction of permanent LIDA designed in accordance with this Chapter; or

b. Construction of a permanent stormwater detention facility designed in accordance with this Chapter; or

c. Construction or funding of a hydromodification approach that is consistent with a District-approved subbasin strategy; or

d. Payment of a Hydromodification Fee-In-Lieu.

Per Section 4.03.3, the receiving reach for this project is Hedges Creek. The Risk Level for the receiving reach identified for this project is Low. The Development Class was determined using the Hydromodification Map provided by CWS, the project site is classified as a Developed Area. Per section 4.08.1 *Impervious Area Used in Design*, the project site is classified as a *Medium Project: over 12,000 to 80,000 square feet.* Using these input parameters, per Table 4-2 *Hydromodification Approach Project Category Table*, the project falls within Category 2. As shown below. See details in the appendices of this report for further information.

TABLE 4-2
HYDROMODIFICATION APPROACH PROJECT CATEGORY TABLE

<table>
<tr><th>Development Class/
Risk Level</th><th>Small Project
1,000 – 12,000 SF</th><th>Medium Project
>12,000 – 80,000 SF</th><th>Large Project
> 80,000 SF</th></tr>
<tr><td>Expansion/High</td><td rowspan="6">Category 1</td><td rowspan="2">Category 3</td><td rowspan="3">Category 3</td></tr>
<tr><td>Expansion/ Moderate</td></tr>
<tr><td>Expansion/ Low</td><td>Category 2</td></tr>
<tr><td>Developed/ High</td><td>Category 3</td></tr>
<tr><td>Developed/ Moderate</td><td rowspan="2">Category 2</td><td rowspan="2">Category 2</td></tr>
<tr><td>Developed/ Low</td></tr>
</table>

Per Section 4.03.5b *Hydromodfication Approach Selection – Category 2*, any of the following options may be used to address hydromodifcation:

1. *Infiltration LIDA, using the Standard LIDA Sizing, described in Section 4.08.5; or*

2. *Peak-Flow Matching Detention, using design criteria described in Section 4.08.6; or*

3. *Combination of Infiltration LIDA and Peak-Flow Matching Detention, using criteria described in Section 4.08.5 and 4.08.6; or*

4. *Any option listed in Category 3.*

3.3 STORMWATER QUALITY

Per Clean Water Services' (CWS) *Design and Construction Standards Manual for Sanitary Sewer and Surface Water Management (R&O 19-5, Amended by R&O 19-22)*, Section 4.08.1 Water Quality Treatment Requirements, the implementation or funding of a permanent water quality approach is required when a new development, or other activities, creates or modifies 1,000 square feet or more of impervious surfaces, or increases the amount of stormwater runoff or pollution leaving the site. Additionally, per Section 4.08 Stormwater Management Approach Sizing, stormwater management approaches are to be sized based on the following:

> *All new impervious surfaces and three times the modified impervious surface, up to the total existing impervious surface on the site. The area requiring treatment is shown in the formula below:*
>
> *Area = New Impervious + 3(Modified Impervious)*
>
> *Impervious areas shall be determined based upon building permits, construction plans, or other appropriate methods of measurement deemed reliable by District and/or City.*

Stormwater quality management for this project will be met by utilizing a new water quality catch basin designed per the requirements of *Clean Water Services' Design and Construction* Standards *(R&O 19-5, Amended by R&O 19-22)*. Any area that will not be able to be treated due to existing site topography will be treated by paying a fee-in-lieu.

4.0 Design Methodology

The Santa Barbara Urban Hydrograph (SBUH) Method was used to analyze stormwater runoff from the site. This method utilizes the SCS Type 1A 24-hour design storm. HydroCAD 10.0 computer software aided in the analysis. Representative runoff Curve Numbers (CN) were obtained from the NRCS *Urban Hydrology for Small Watersheds* (Technical Release 55*)* and are included in the appendices.

5.0 Design Parameters

5.1 DESIGN STORMS

Stormwater mains, inlets, and laterals for the site are placed at locations that adequately collect and convey the stormwater for the proposed improvements. Per CWS Section 5.05.2, the stormwater analysis utilized the 24-hour storm for the evaluation and design of the existing and proposed

stormwater facilities. The following 24-hour rainfall intensities from CWS Standard Drawing No. 1280 were utilized as the design storms for the recurrence interval:

Table 5-1: Rainfall Intensities	
Recurrence Interval (Years)	**Total Precipitation Depth (Inches)**
2	2.50
5	3.10
10	3.45
25	3.90

5.2 PRE-DEVELOPED SITE CONDITIONS

5.2.1 Site Topography

Existing on-site grades generally vary from ±1% to 10%, with most of the site draining towards the north before entering into a private storm system before discharging to the public system (Existing SW Tualatin Sherwood Road). The site has a high point of ±165 feet at the southeast property corner and a local low point of ±155 feet near the northeast corner of the site.

5.2.2 Land Use

The existing site consists of Praxair Inc. with associated buildings, an asphalt driveway, parking lots, sidewalks, various chemical tanks, and landscaping. The site is located in Tualatin's General Manufacturing Zone (MG).

5.3 SOIL TYPE

The soil beneath the project site and associated drainage basins is classified as Amity Silt Loam, according to the USDA Soil Survey for Washington County. The following table outlines the Hydrologic Soil Group rating for the soil type:

Table 5-2: Hydrologic Soil Group Ratings		
NRCS Map Unit Identification	**NRCS Soil Classification**	**Hydrologic Soil Group Rating**
2	Amity Silt Loam	C/D
45A	Woodburn Silt Loam (0-3% slopes)	C
45B	Woodburn Silt Loam (3-7% slopes)	C

Further information on this soil type is included in the NRCS Soil Resource Report located in the appendices of this report.

5.4 POST-DEVELOPED SITE CONDITIONS

5.4.1 Site Topography

The on-site slopes will remain largely the same with the construction of the site improvements, associated access, and related stormwater facilities.

5.4.2 Land Use

The site land-use will remain unchanged.

5.4.3 Description of Off-Site Contributing Basins

A portion of the property to the south is expected to flow onto the project site. This contributing basin is relatively flat and heavily wooded therefore a small flow is expected. These flows have been ignored for the purpose of this preliminary design, but will be accommodated for in the final design.

6.0 Stormwater Analyses

6.1 PROPOSED STORMWATER CONDUIT SIZING AND INLET SPACING

The proposed catch basin will be placed per engineering judgement to properly collect and convey stormwater runoff. The proposed storm system pipes will be sized using Manning's equation to convey the peak flows from the 25-year storm event.

6.2 PROPOSED STORMWATER QUALITY CONTROL FACILITY

This project is comprised of new development and redevelopment. Therefore, per Clean Water Services' (CWS) *Design and Construction Standards Manual for Sanitary Sewer and Surface Water Management (R&O 19-5, Amended by R&O 19-22)*, Section 4.08 Stormwater Management Approach Sizing, the impervious area requiring treatment is defined as: *Area = New Imp. + 3(Modified Imp.)*. The impervious areas are summarized in Table 6-1.

Table 6-1: Impervious Area Summary

New Impervious Area (sq. ft.)	Modified Impervious Area (sq. ft.)	Permanently Removed Impervious Area (sq. ft.)	Area Required to be Treated (sq. ft.)
21,140	360	0	22,220

Basin 1S represents impervious area being treated by new water quality catch basin with two (2) storm filter cartridges. Basin 2S represents area that will not be captured and treated due to existing site topography. This untreated area will be treated by paying a fee-in-lieu. For more information regarding water quality see Table 6-2 below. The proposed development will utilize this water quality catch basin and a fee-in-lieu designed per Clean Water Services' *Design and Construction Standards for Sanitary Sewer and Surface Water Management (R&O 19-5, Amended by R&O 19-22)* to provide water quality treatment.

Table 6-2: Impervious Area Treatment Summary

Area to be Treated by WQ Catch Basin 1 (sq. ft.)	Area to be Treated by Fee-In-Lieu (sq. ft.)	Total Area to be Treated (sq. ft.)
21,240	980	22,220

6.3 HYDROMODIFICATION

The proposed site improvements will reduce impacts to the downstream receiving water body by implementing a detention system and flow control manhole designed per CWS' standards. Per Section 4.03.5b *Hydromodification Approach Selection – Category 2*, hydromodification will be met by peak-flow matching detention. For additional information regarding the sizing of the detention system and flow control manhole, refer to Section 6.4 of this report.

6.4 PROPOSED STORMWATER QUANITITY CONTROL FACILITY

The proposed on-site improvements will utilize an underground Stormtech chamber system and a flow control manhole to provide detention for the new and redeveloped impervious areas per CWS' standards. Basin 1S is composed of new impervious area that will be collected and detained in the new chamber system. Basin 2S is composed of modified impervious area that will not be captured by the

new detention system due to existing site topography. To mitigate for the undetained flows from Basin 2S, all of Basin 1S will be over-detained and released to meet stormwater quantity mitigation. See Table 6-3 for details.

See equations 1 & 2 for additional information regarding the allowable release rate for each storm event. Equation 1 defines the allowable release for only 50% of the 2-year storm event analysis, while equation 2 defines the allowable release for the remainder of the storm events.

Equation 1: 50% of the 2-Year Only

$$Allowable = \frac{1ES}{2} - 2S$$

$$Allowable\ (50\%\ of\ 2\ Year) = \frac{(0.15\ cfs)}{2} - (0.00\ cfs) = 0.08\ cfs$$

Equation 2: 2, 5, 10, and 25-year Storm Events

$$Allowable = 1ES - 2S$$

$$Allowable\ (25\ Year) = (0.31\ cfs) - (0.01\ cfs) = 0.30\ cfs$$

Table 6-3: Stormwater Runoff Flow Summary

Storm Event (Years)	Predeveloped Flows from area to be Developed (cfs) (Basin 1ES)	Post-Developed Undetained Release (cfs) (Basin 2S)	Post-Developed Detained Allowable Release (cfs)	Post-Developed Detained Flows (cfs)	Difference (cfs)
50% of 2	0.08	0.00	0.08	0.06	-0.02
2	0.15	0.00	0.15	0.06	-0.09
5	0.22	0.00	0.22	0.13	-0.09
10	0.26	0.00	0.26	0.17	-0.09
25	0.31	0.01	0.30	0.22	-0.08

6.5 DOWNSTREAM ANALYSIS

Per CWS *Design Standards (R&O 19-5, Amended by R&O 19-22)*, Section 2.04.2 Initial Plan Submittal Requirements:

2.04.2.m.3 Review of Downstream Conveyance System:

- *A. For each development constructing new impervious surface of greater than 5,280 square feet, or collecting and discharging greater than 5,280 square feet of impervious area, except for the construction of a detached single family dwelling or duplex, the design Engineer shall perform a capacity and condition analysis of existing downstream storm facilities and conveyance elements receiving flow from the proposed development.*
- *B. The analysis shall extend downstream to a point in the drainage system where the additional flow from the proposed development site constitutes 10 percent or less of the total tributary drainage flow.*
- *C. Where the additional flow from the proposed development drops to less than 10 percent of the total tributary drainage flow, then the analysis will continue for the lesser of:*
  - *i. One-quarter (1/4) of a mile; or*
  - *ii. Until the additional flow constitutes less than 5 percent of the total tributary drainage flow*
- *D. When the downstream analysis does not continue for at least one-quarter (1/4) mile, the design engineer shall provide a stamped Certification of Investigation that states the design*

Engineer has visually investigated the downstream system for at least one-quarter (1/4) mile downstream and is aware of no observable downstream impacts to structures.

Stormwater runoff from the site will be routed from the new stormwater facility to the existing stormwater system in SW Tualatin Sherwood Road. The existing pipe network services a portion of Praxair's existing facilities and landscaping, in addition to the surrounding commercial businesses to the east.

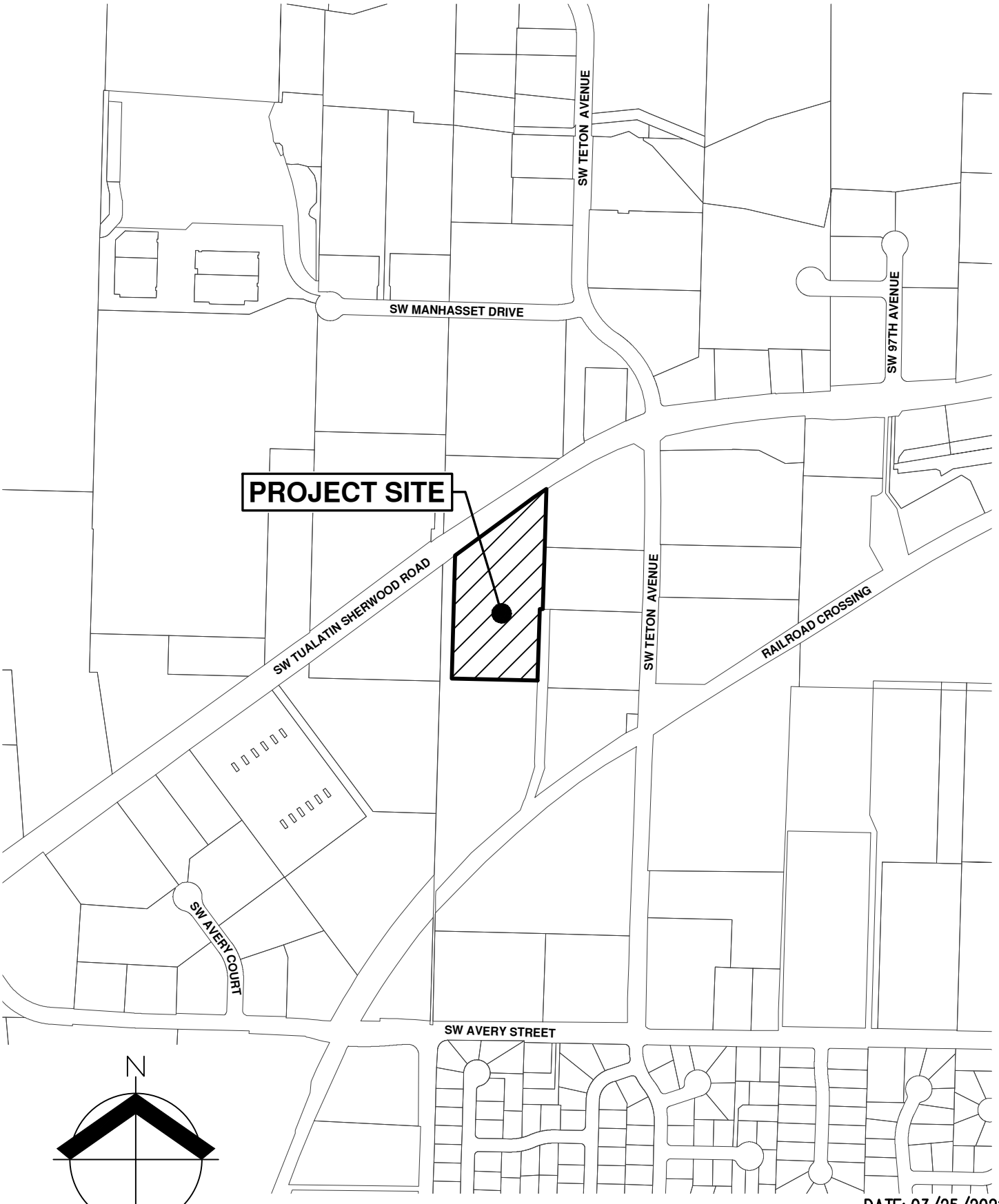
From available GIS data, pipe sizes increase further downstream of the project site before eventually discharging into a nearby storm facility on SW Tualatin Sherwood Road. This stormwater facility is located within a (1/4) mile from the project site's discharge point.

Stormwater runoff from the proposed improvements will be detained by the new stormwater detention facility and conveyed via the existing stormwater conveyance systems. Runoff values from the development are reduced from the existing pre-developed rates. As such, further improvements within the public right-of-way are not required as part of this development.

7.0 Stormwater Analyses

A stormwater management system has been designed per Clean Water Services' (CWS) *Design and Construction Standards Manual for Sanitary and Surface Water Management (R&O 19-5, Amended by R&O 19-22)* and the supporting documentation is contained in this report. Stormwater quality management will be provided for all new impervious areas with the construction of a new storm filter catch basin with (2) cartridges and by paying a fee-in-lieu for any area that is not able to be captured and treated. Additionally, the proposed detention system and flow control manhole have been designed to satisfy stormwater quantity and hydromodification requirements in compliance with CWS standards. With the improvements proposed, stormwater requirements have been met.

Appendix A: Vicinity Map



SCALE: 1"= 500 FEET

500 0 100 250 500

DATE: 03/25/2021

PRAXAIR VICINITY MAP

EXHIBIT **A**

AKS ENGINEERING & FORESTRY, LLC
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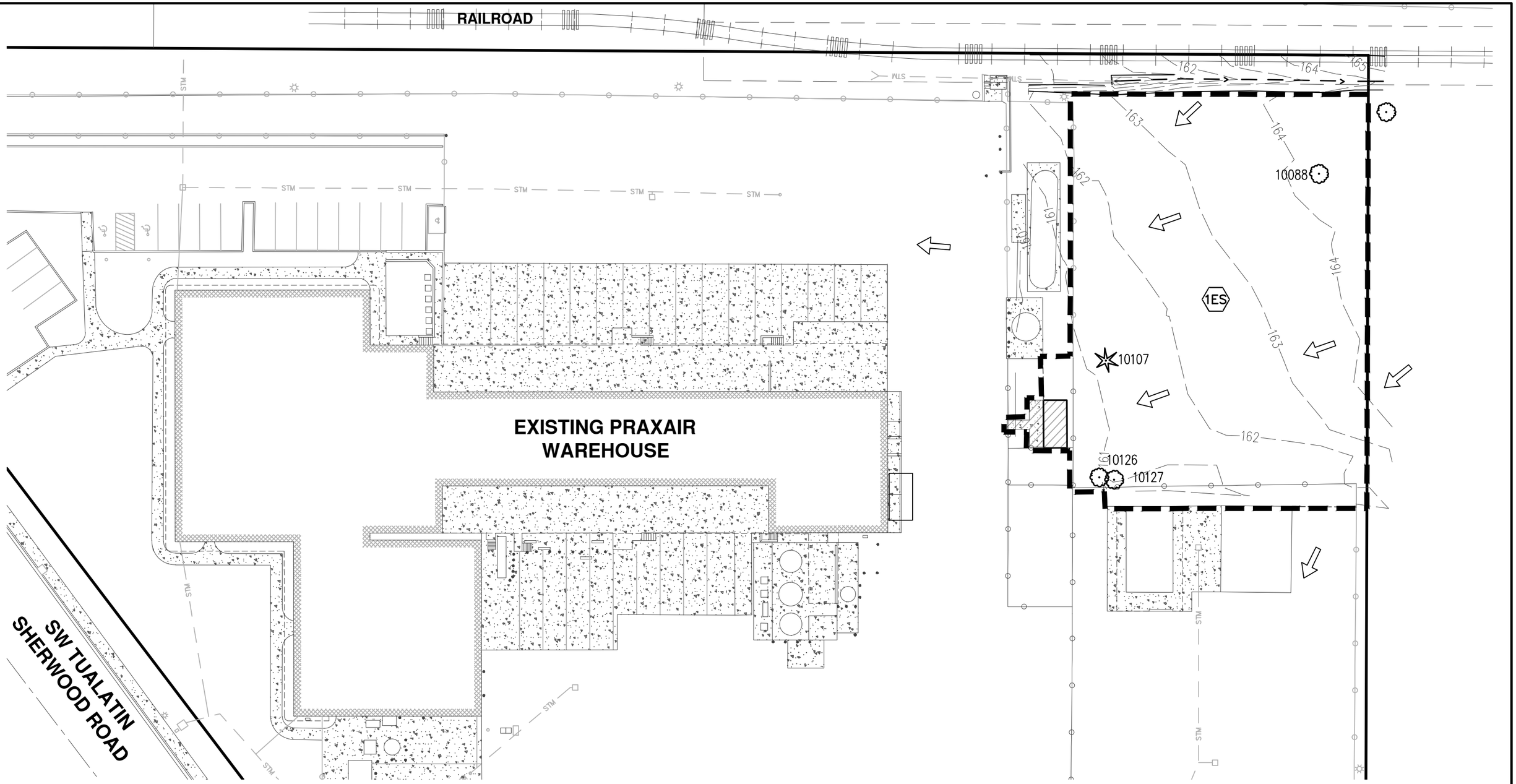
DRWN: TMI
CHKD: CAK
AKS JOB: 7784

Appendix B: Pre-Developed and Post-Developed Basin Maps



1ES PRE-DEVELOPED SITE AREA TO BE DEVELOPED

2ES PRE-DEVELOPED SITE AREA TO REMAIN AND BE TREATED BY FUTURE WATER QUALITY CATCH BASIN 2

PRE-DEVELOPED SURFACE FLOW ARROW

POST-DEVELOPED SURFACE FLOW ARROW

IMPERVIOUS AREA TO BE MODIFIED

PRE-DEVELOPED AREA SUMMARY	
TOTAL AREA	= ±22,220 SF
TOTAL EXISTING PERVIOUS AREA	= ±21,920 SF
IMPERVIOUS AREA TO BE MODIFIED	= ±360 SF

N

SCALE: 1"= 40 FEET

40 0 8 20 40

ORIGINAL PAGE SIZE: 22" x 34"

DATE: 03/31/2021

PRE-DEVELOPED BASIN MAP

EXHIBIT **B**

PRAXAIR SITE IMPROVEMENTS

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RAILROAD

EXISTING PRAXAIR
WAREHOUSE

SW TUALATIN
SHERWOOD ROAD

1S POST-DEVELOPED SITE AREA TO BE DETAINED AND TREATED BY WATER QUALITY CATCH BASIN 1

2S POST-DEVELOPED SITE AREA TO BE UNDETAINED

PRE-DEVELOPED SURFACE FLOW ARROW

POST-DEVELOPED SURFACE FLOW ARROW

NEW IMPERVIOUS AREA

IMPERVIOUS AREA SUMMARY		
NEW IMPERVIOUS AREA	=	±21,140 SF
TOTAL IMPERVIOUS AREA	=	±22,280 SF
IMP. AREA TO BE TREATED BY WQ CATCH BASIN 1	=	±21,240 SF
IMP. AREA TO BE TREATED BY WQ CREDITS	=	±980 SF

N

SCALE: 1"= 40 FEET

40 0 8 20 40

ORIGINAL PAGE SIZE: 22" x 34"

DATE: 03/31/2021

POST-DEVELOPED BASIN MAP

EXHIBIT C

PRAXAIR SITE IMPROVEMENTS

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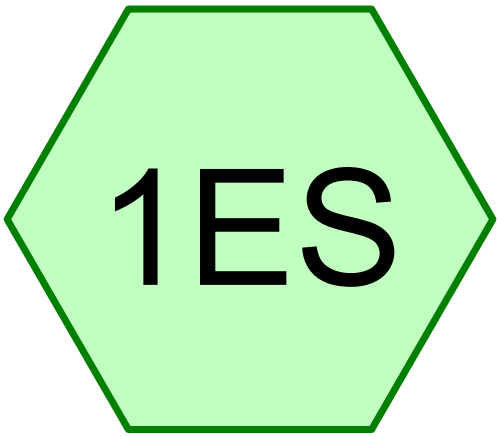
DRWN: TMI
CHKD: CAK
AKS JOB: 7784

Appendix C: Pre-developed and Post-Developed HydroCAD Analysis



Pre-Developed Site Area

Subcat Reach Pond Link

Routing Diagram for 7784 Pre-Developed
Prepared by AKS Engineering & Forestry, Printed 3/31/2021

Summary for Subcatchment 1ES: Pre-Developed Site Area

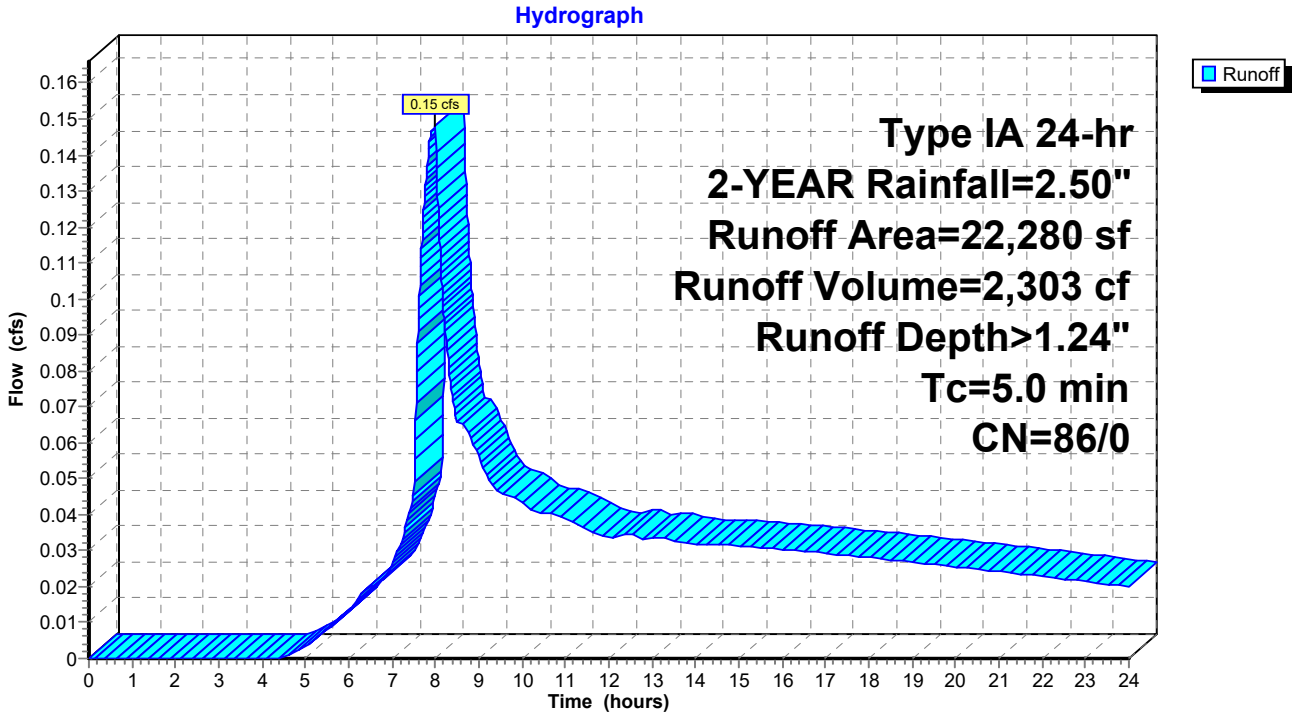
Runoff = 0.15 cfs @ 7.97 hrs, Volume= 2,303 cf, Depth> 1.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-YEAR Rainfall=2.50"

	Area (sf)	CN	Description
	0	98	Paved parking & roofs
*	360	75	Redeveloped Imp Area
*	21,920	86	Pervious Area
	22,280	86	Weighted Average
	22,280		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1ES: Pre-Developed Site Area



Summary for Subcatchment 1ES: Pre-Developed Site Area

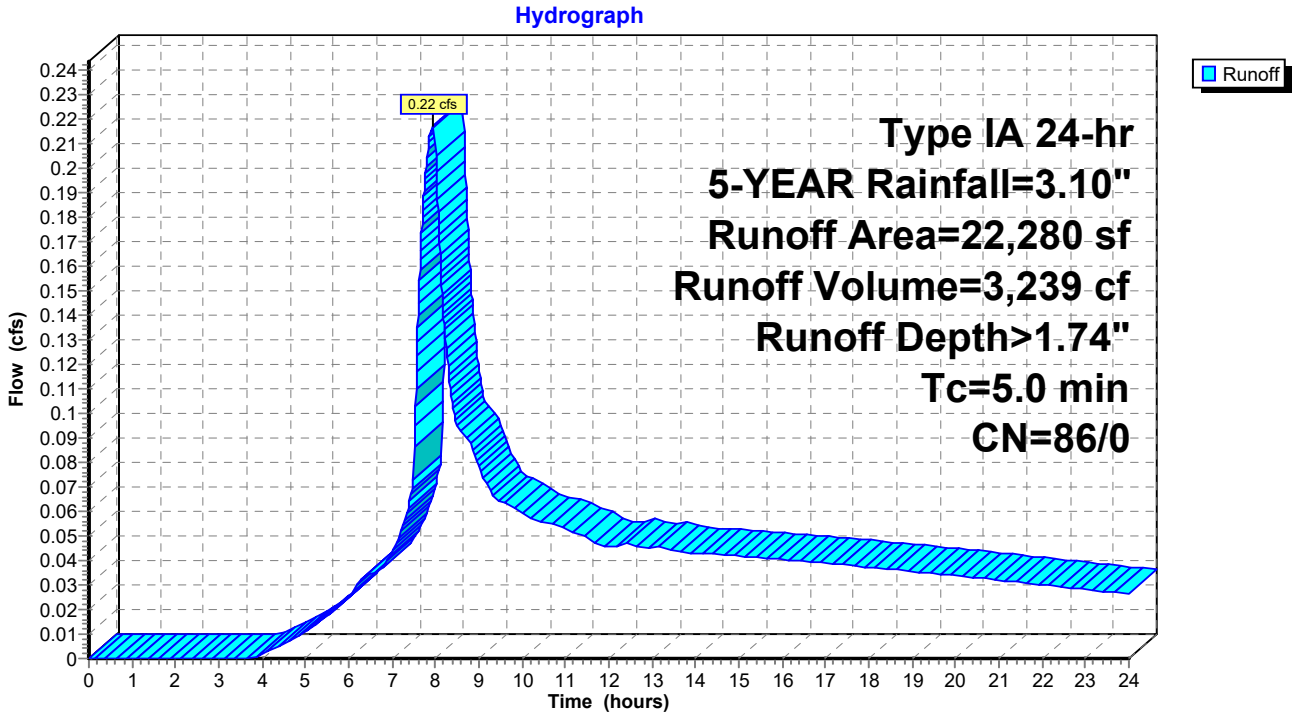
Runoff = 0.22 cfs @ 7.95 hrs, Volume= 3,239 cf, Depth> 1.74"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-YEAR Rainfall=3.10"

	Area (sf)	CN	Description
	0	98	Paved parking & roofs
*	360	75	Redeveloped Imp Area
*	21,920	86	Pervious Area
	22,280	86	Weighted Average
	22,280		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1ES: Pre-Developed Site Area



Summary for Subcatchment 1ES: Pre-Developed Site Area

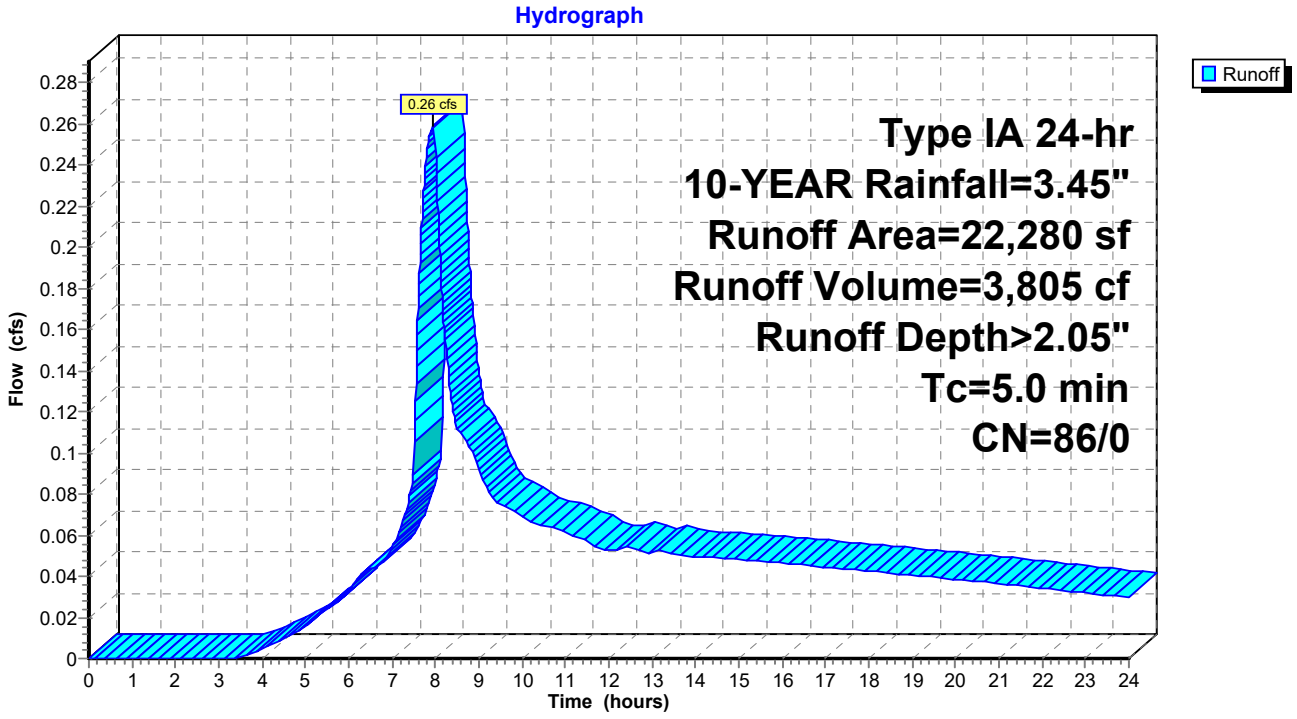
Runoff = 0.26 cfs @ 7.94 hrs, Volume= 3,805 cf, Depth> 2.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-YEAR Rainfall=3.45"

	Area (sf)	CN	Description
	0	98	Paved parking & roofs
*	360	75	Redeveloped Imp Area
*	21,920	86	Pervious Area
	22,280	86	Weighted Average
	22,280		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1ES: Pre-Developed Site Area



Summary for Subcatchment 1ES: Pre-Developed Site Area

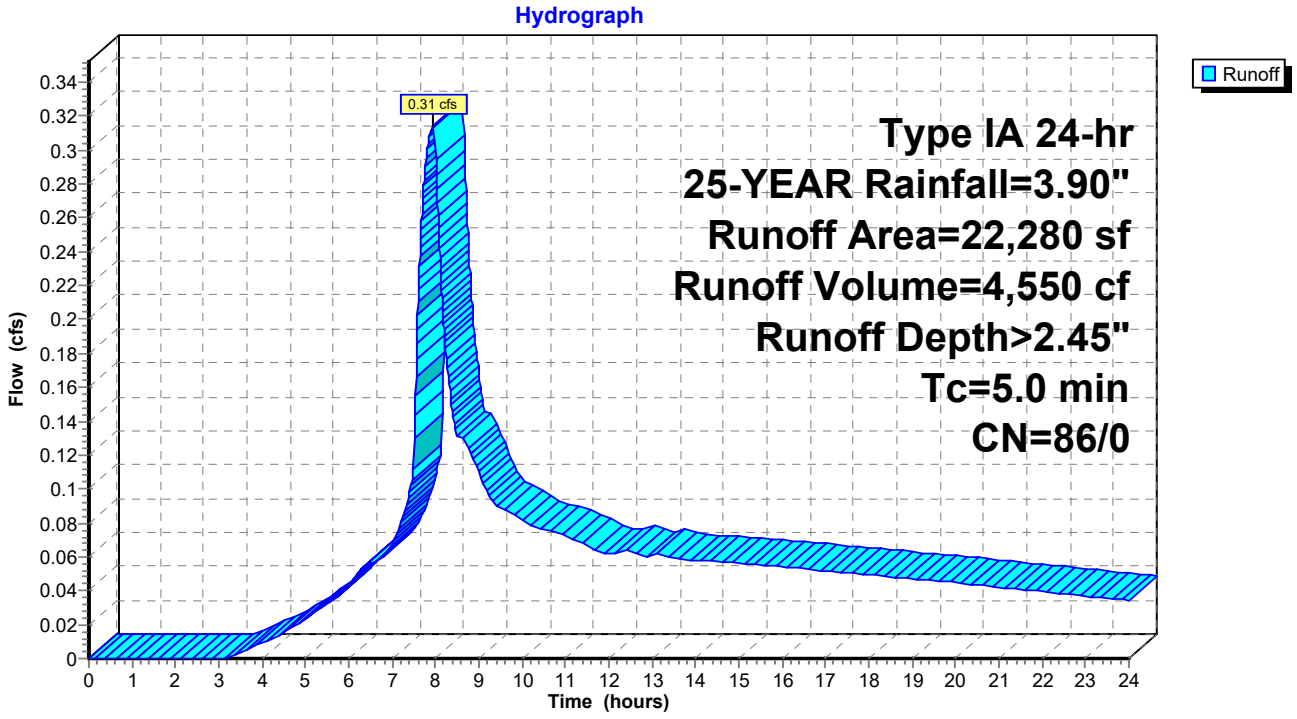
Runoff = 0.31 cfs @ 7.94 hrs, Volume= 4,550 cf, Depth> 2.45"

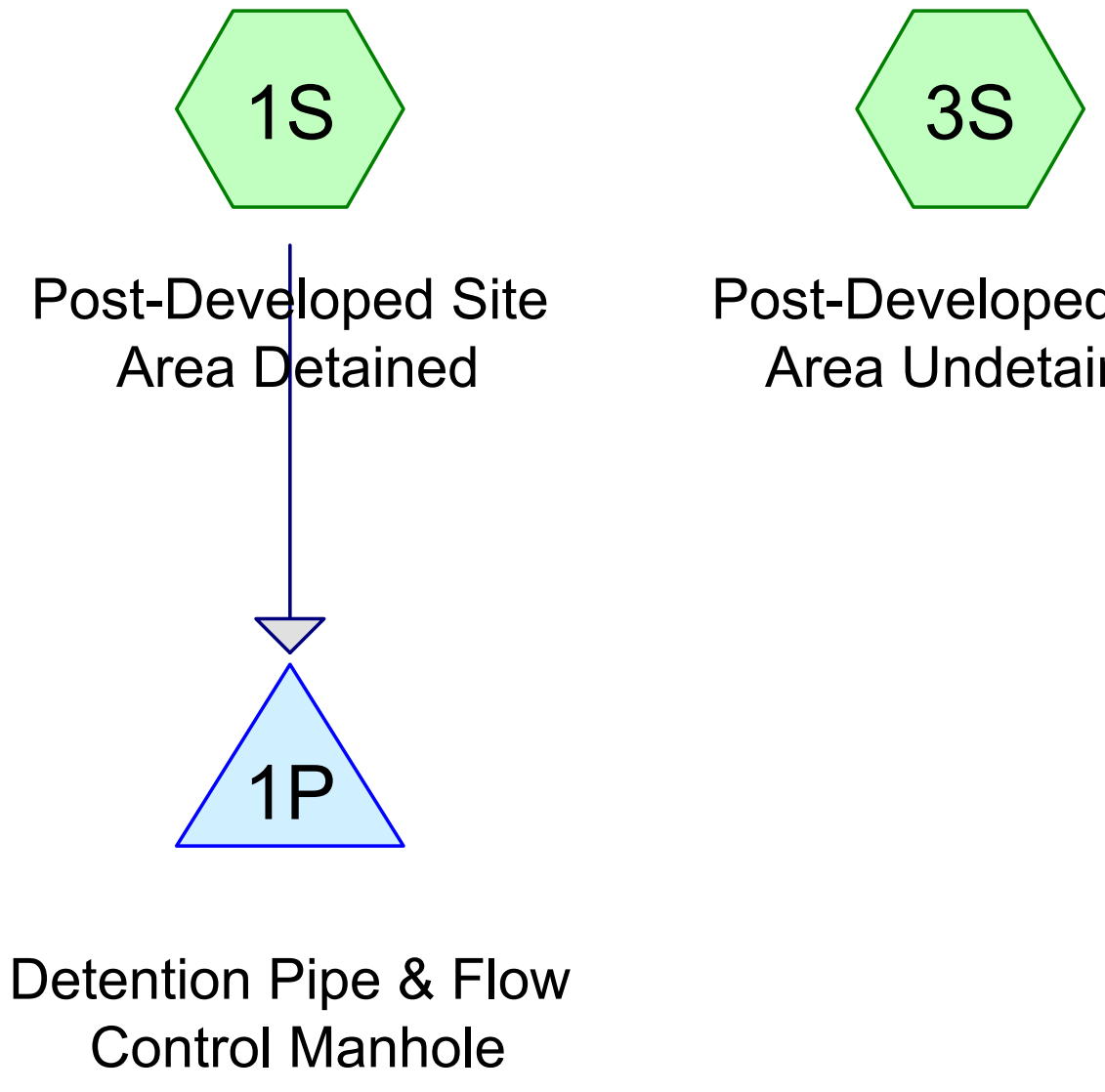
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-YEAR Rainfall=3.90"

	Area (sf)	CN	Description
	0	98	Paved parking & roofs
*	360	75	Redeveloped Imp Area
*	21,920	86	Pervious Area
	22,280	86	Weighted Average
	22,280		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1ES: Pre-Developed Site Area





Subcat Reach Pond Link

Routing Diagram for 7784 Post-Developed - Chambers
Prepared by AKS Engineering & Forestry, Printed 3/31/2021

Summary for Subcatchment 1S: Post-Developed Site Area Detained

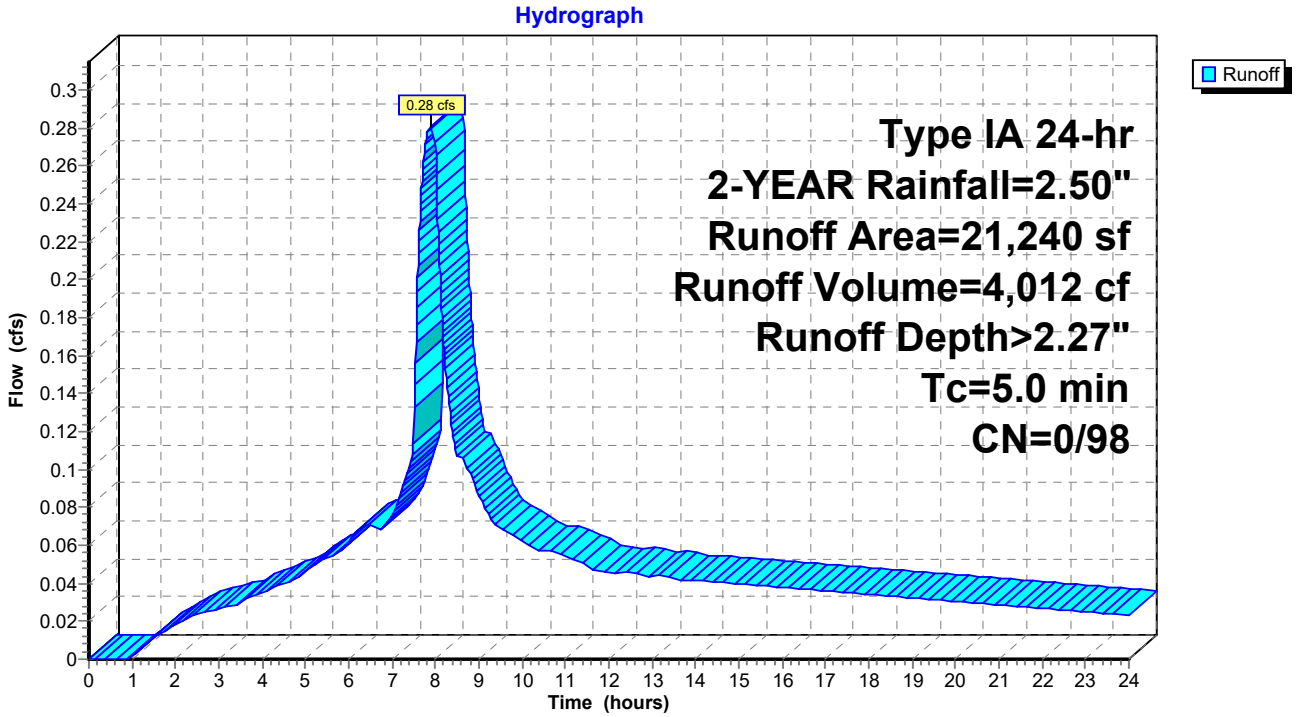
Runoff = 0.28 cfs @ 7.88 hrs, Volume= 4,012 cf, Depth> 2.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-YEAR Rainfall=2.50"

	Area (sf)	CN	Description
*	21,240	98	Gravel Area
	21,240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Post-Developed Site Area Detained



Summary for Subcatchment 3S: Post-Developed Site Area Undetained

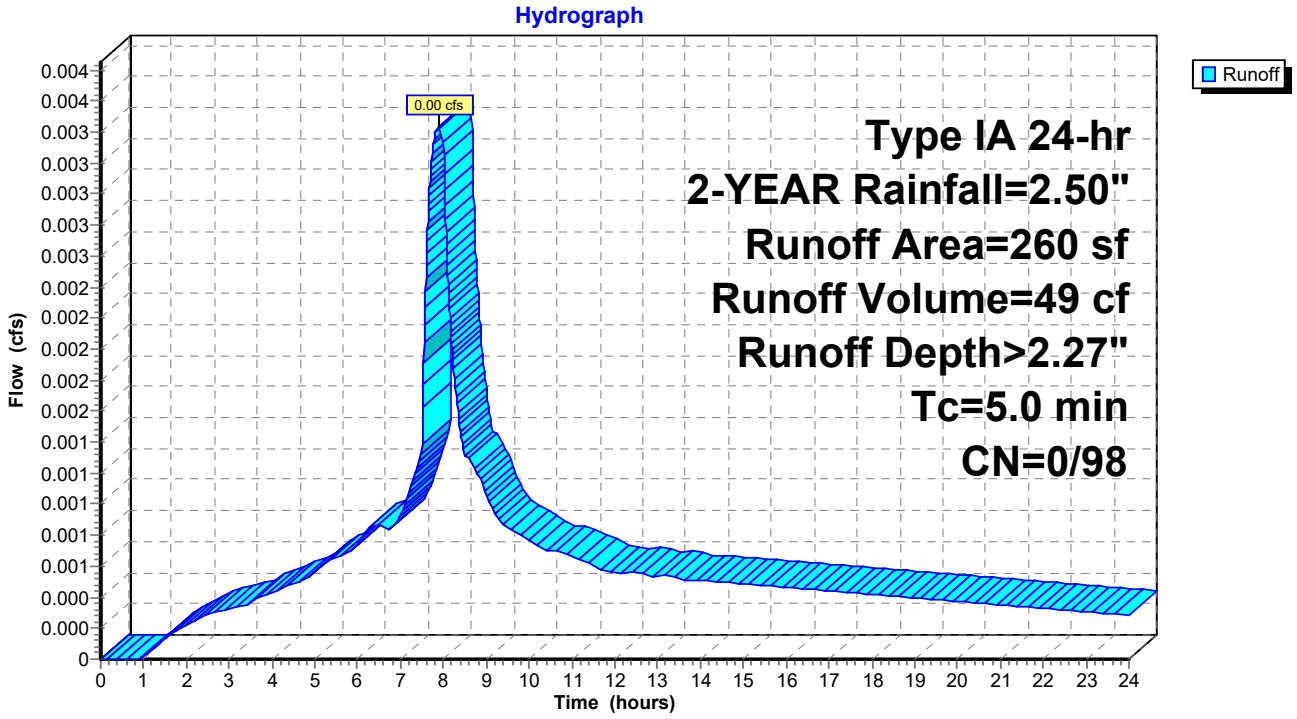
Runoff = 0.00 cfs @ 7.88 hrs, Volume= 49 cf, Depth> 2.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-YEAR Rainfall=2.50"

	Area (sf)	CN	Description
*	260	98	Gravel Area
	260		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: Post-Developed Site Area Undetained



Summary for Pond 1P: Detention Pipe & Flow Control Manhole

Inflow Area = 21,240 sf,100.00% Impervious, Inflow Depth > 2.27" for 2-YEAR event
Inflow = 0.28 cfs @ 7.88 hrs, Volume= 4,012 cf
Outflow = 0.06 cfs @ 10.76 hrs, Volume= 2,454 cf, Atten= 80%, Lag= 172.8 min
Primary = 0.06 cfs @ 10.76 hrs, Volume= 2,454 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 157.04' @ 10.76 hrs Surf.Area= 1,096 sf Storage= 1,713 cf

Plug-Flow detention time= 443.1 min calculated for 2,454 cf (61% of inflow)
Center-of-Mass det. time= 219.1 min (890.3 - 671.3)

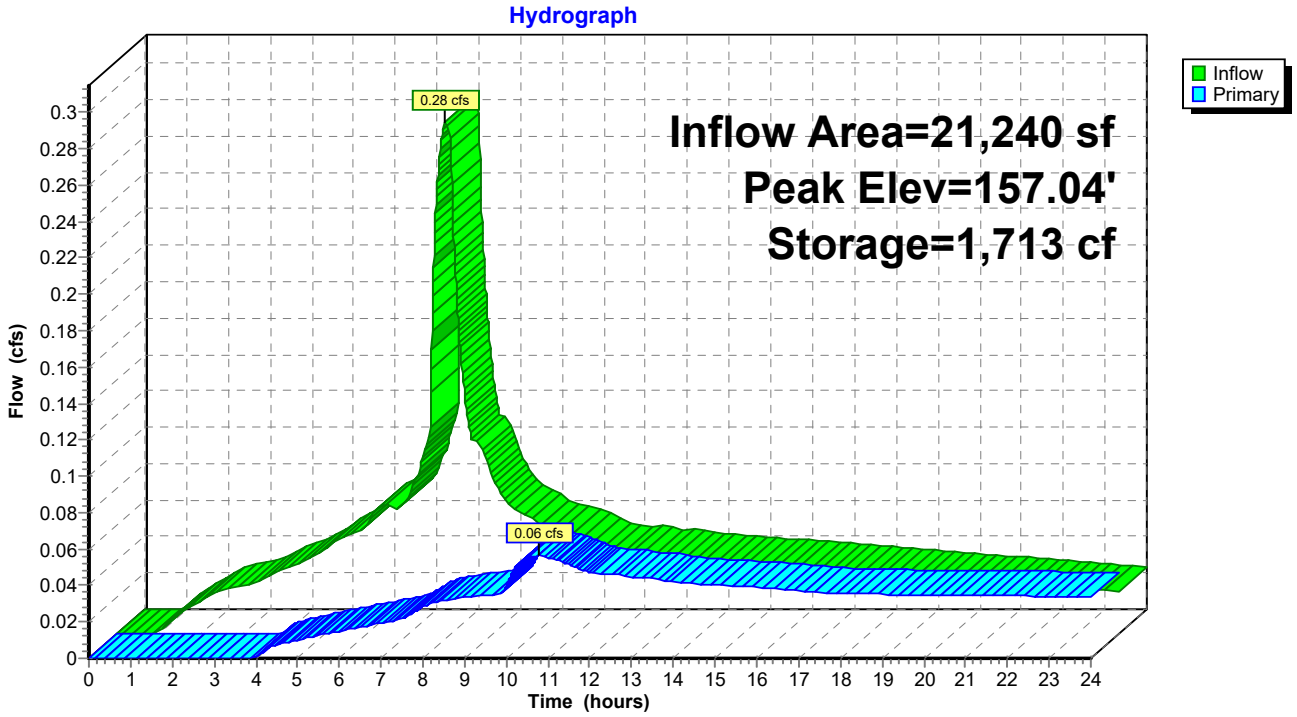
Volume	Invert	Avail.Storage	Storage Description
#1A	154.70'	1,020 cf	**20.50'W x 53.46'L x 3.50'H Field A** 3,836 cf Overall - 1,286 cf Embedded = 2,549 cf x 40.0% Voids
#2A	155.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 4 Rows of 7 Chambers
		2,306 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	155.20'	**1.0" Horiz. Orifice** C= 0.600 Limited to weir flow at low heads
#2	Device 4	157.00'	**3.0" Horiz. 4.0" Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 4	159.33'	**12.0" Horiz. 12" Orifice** C= 0.600 Limited to weir flow at low heads
#4	Primary	155.20'	**8.0" Round Culvert** L= 147.3' Ke= 0.500 Inlet / Outlet Invert= 155.20' / 153.84' S= 0.0092 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.06 cfs @ 10.76 hrs HW=157.04' (Free Discharge)
└**4=Culvert** (Passes 0.06 cfs of 1.45 cfs potential flow)
  ├**1=Orifice** (Orifice Controls 0.04 cfs @ 6.53 fps)
  ├**2=4.0" Orifice** (Weir Controls 0.02 cfs @ 0.65 fps)
  └**3=12" Orifice** (Controls 0.00 cfs)

Pond 1P: Detention Pipe & Flow Control Manhole



Summary for Subcatchment 1S: Post-Developed Site Area Detained

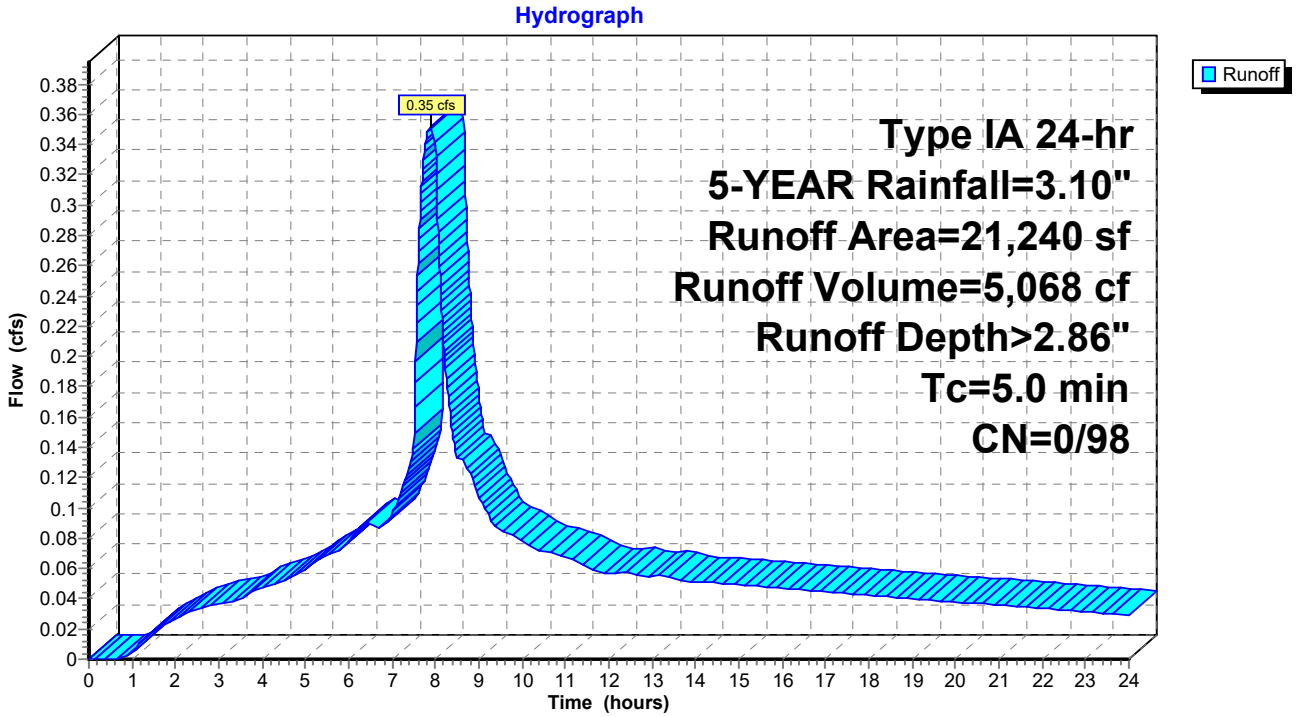
Runoff = 0.35 cfs @ 7.88 hrs, Volume= 5,068 cf, Depth> 2.86"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-YEAR Rainfall=3.10"

	Area (sf)	CN	Description
*	21,240	98	Gravel Area
	21,240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Post-Developed Site Area Detained



Summary for Subcatchment 3S: Post-Developed Site Area Undetained

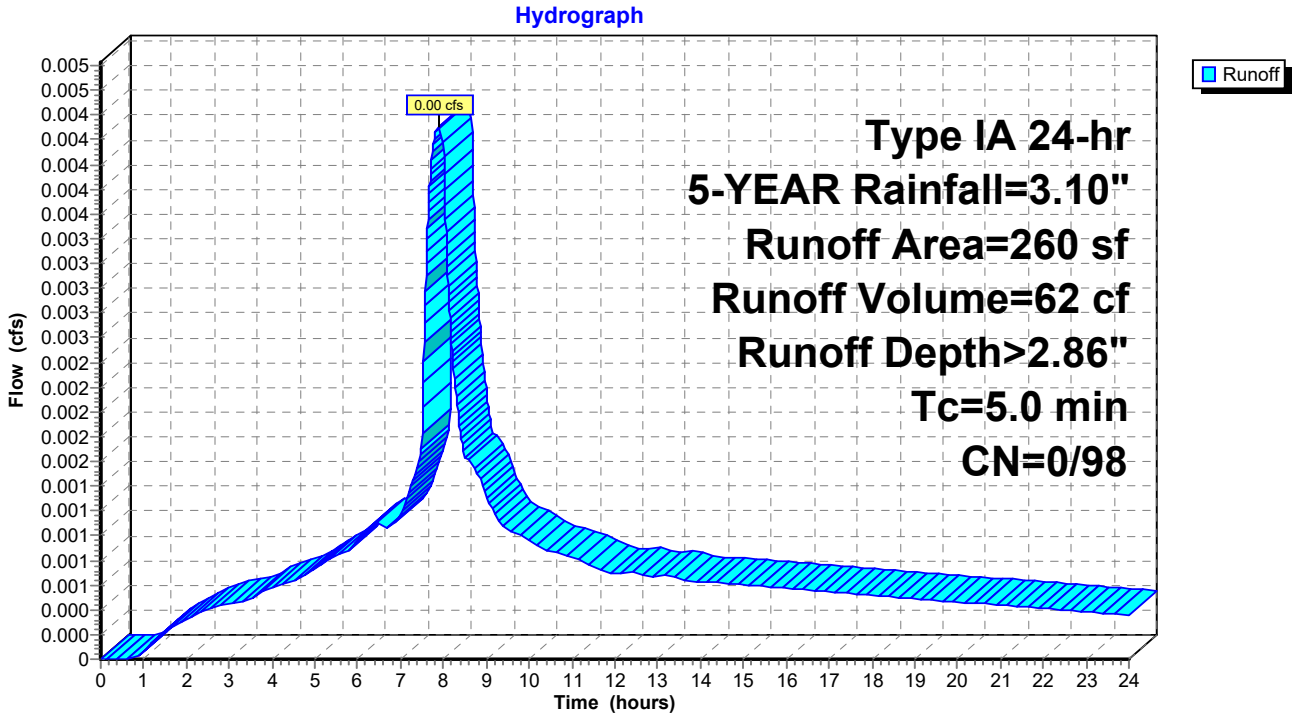
Runoff = 0.00 cfs @ 7.88 hrs, Volume= 62 cf, Depth> 2.86"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-YEAR Rainfall=3.10"

	Area (sf)	CN	Description
*	260	98	Gravel Area
	260		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: Post-Developed Site Area Undetained



Summary for Pond 1P: Detention Pipe & Flow Control Manhole

Inflow Area = 21,240 sf,100.00% Impervious, Inflow Depth > 2.86" for 5-YEAR event
Inflow = 0.35 cfs @ 7.88 hrs, Volume= 5,068 cf
Outflow = 0.13 cfs @ 8.75 hrs, Volume= 3,412 cf, Atten= 64%, Lag= 52.3 min
Primary = 0.13 cfs @ 8.75 hrs, Volume= 3,412 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 157.14' @ 8.75 hrs Surf.Area= 1,096 sf Storage= 1,782 cf

Plug-Flow detention time= 359.2 min calculated for 3,412 cf (67% of inflow)
Center-of-Mass det. time= 160.8 min (825.6 - 664.8)

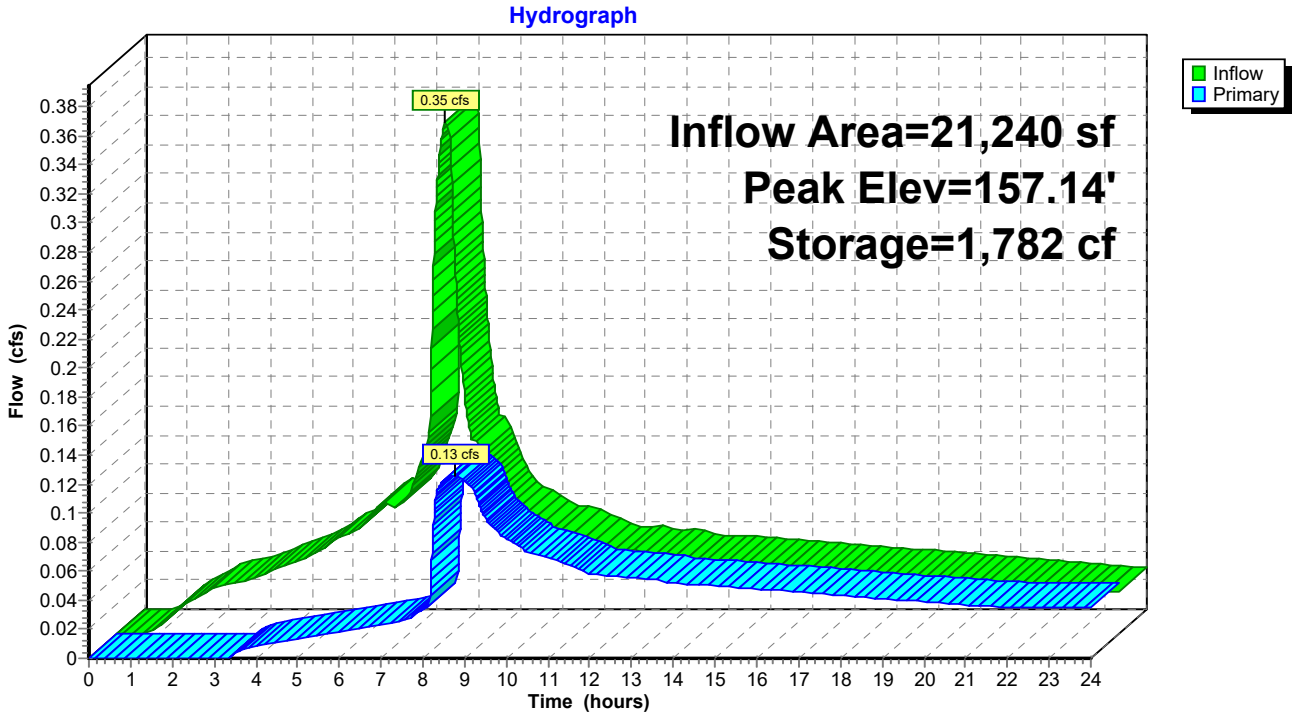
Volume	Invert	Avail.Storage	Storage Description
#1A	154.70'	1,020 cf	**20.50'W x 53.46'L x 3.50'H Field A** 3,836 cf Overall - 1,286 cf Embedded = 2,549 cf x 40.0% Voids
#2A	155.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 4 Rows of 7 Chambers
		2,306 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	155.20'	**1.0" Horiz. Orifice** C= 0.600 Limited to weir flow at low heads
#2	Device 4	157.00'	**3.0" Horiz. 4.0" Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 4	159.33'	**12.0" Horiz. 12" Orifice** C= 0.600 Limited to weir flow at low heads
#4	Primary	155.20'	**8.0" Round Culvert** L= 147.3' Ke= 0.500 Inlet / Outlet Invert= 155.20' / 153.84' S= 0.0092 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.13 cfs @ 8.75 hrs HW=157.14' (Free Discharge)
└**4=Culvert** (Passes 0.13 cfs of 1.48 cfs potential flow)
  ├**1=Orifice** (Orifice Controls 0.04 cfs @ 6.71 fps)
  ├**2=4.0" Orifice** (Orifice Controls 0.09 cfs @ 1.82 fps)
  └**3=12" Orifice** (Controls 0.00 cfs)

Pond 1P: Detention Pipe & Flow Control Manhole



Summary for Subcatchment 1S: Post-Developed Site Area Detained

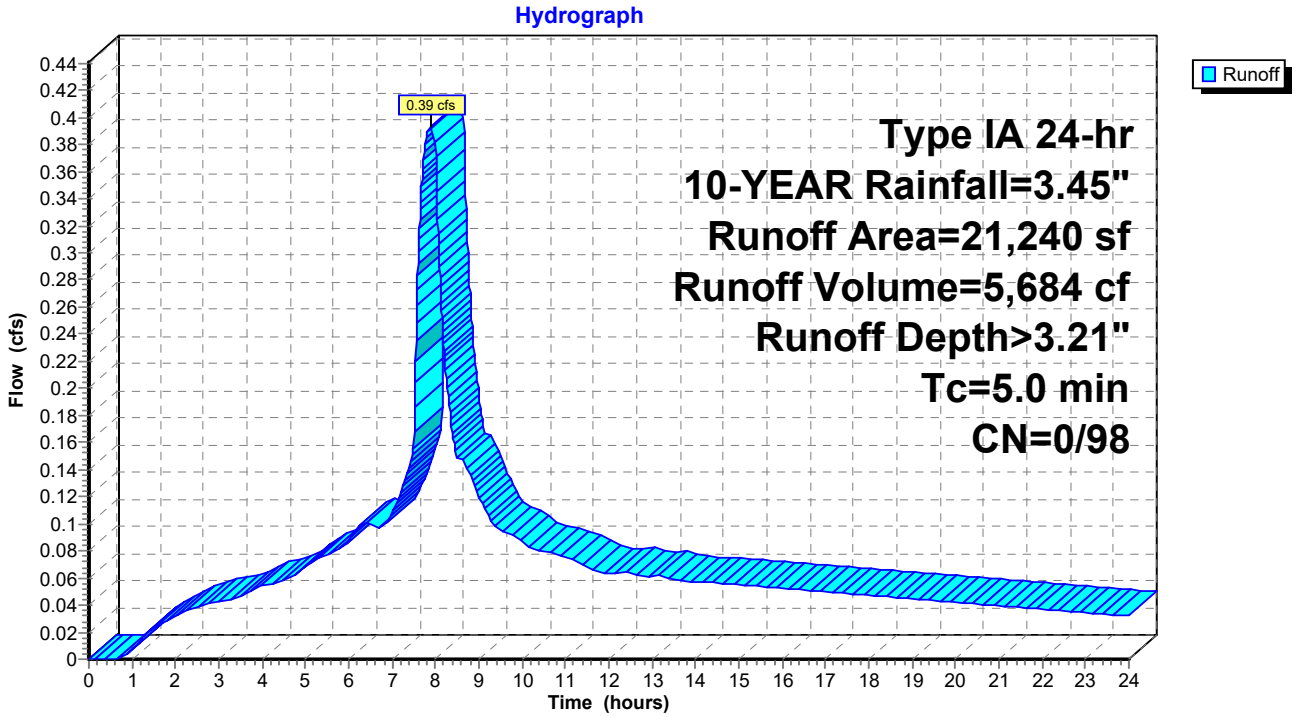
Runoff = 0.39 cfs @ 7.88 hrs, Volume= 5,684 cf, Depth> 3.21"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-YEAR Rainfall=3.45"

	Area (sf)	CN	Description
*	21,240	98	Gravel Area
	21,240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Post-Developed Site Area Detained



Summary for Subcatchment 3S: Post-Developed Site Area Undetained

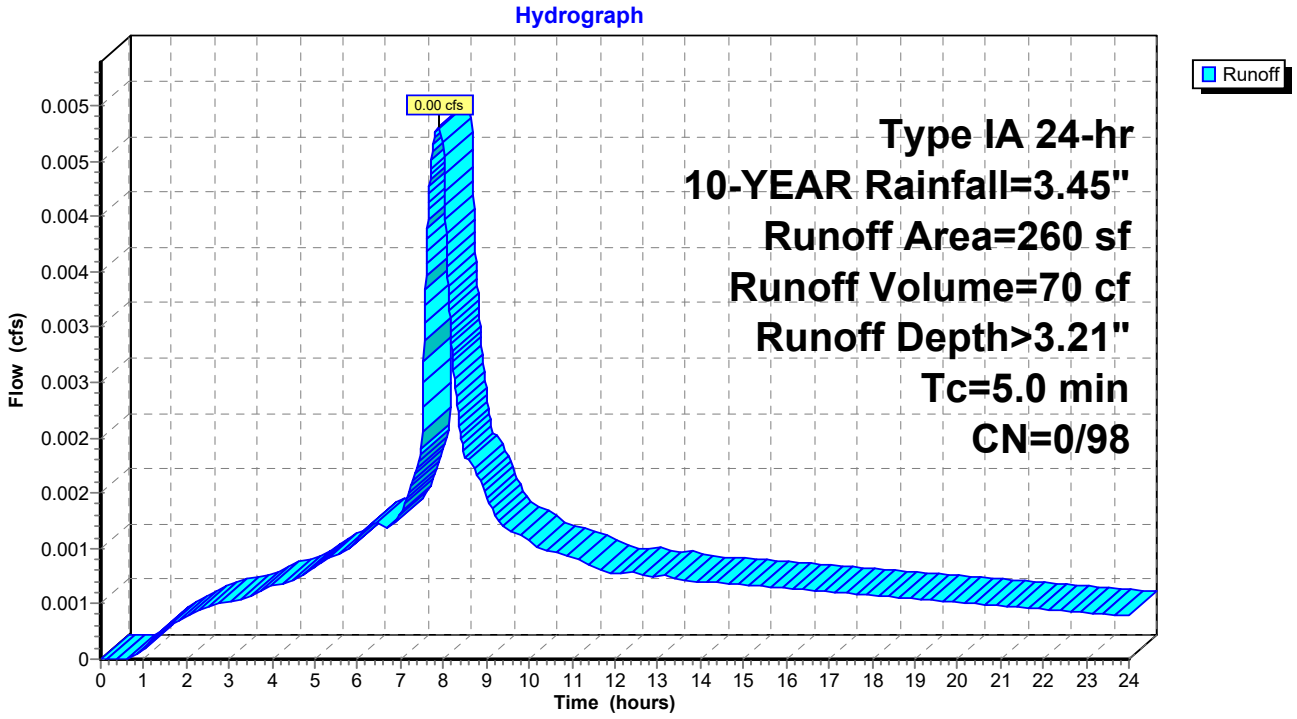
Runoff = 0.00 cfs @ 7.88 hrs, Volume= 70 cf, Depth> 3.21"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-YEAR Rainfall=3.45"

	Area (sf)	CN	Description
*	260	98	Gravel Area
	260		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: Post-Developed Site Area Undetained



Summary for Pond 1P: Detention Pipe & Flow Control Manhole

Inflow Area = 21,240 sf,100.00% Impervious, Inflow Depth > 3.21" for 10-YEAR event
Inflow = 0.39 cfs @ 7.88 hrs, Volume= 5,684 cf
Outflow = 0.17 cfs @ 8.39 hrs, Volume= 4,004 cf, Atten= 57%, Lag= 31.0 min
Primary = 0.17 cfs @ 8.39 hrs, Volume= 4,004 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 157.30' @ 8.39 hrs Surf.Area= 1,096 sf Storage= 1,882 cf

Plug-Flow detention time= 325.9 min calculated for 4,002 cf (70% of inflow)
Center-of-Mass det. time= 142.0 min (803.9 - 661.9)

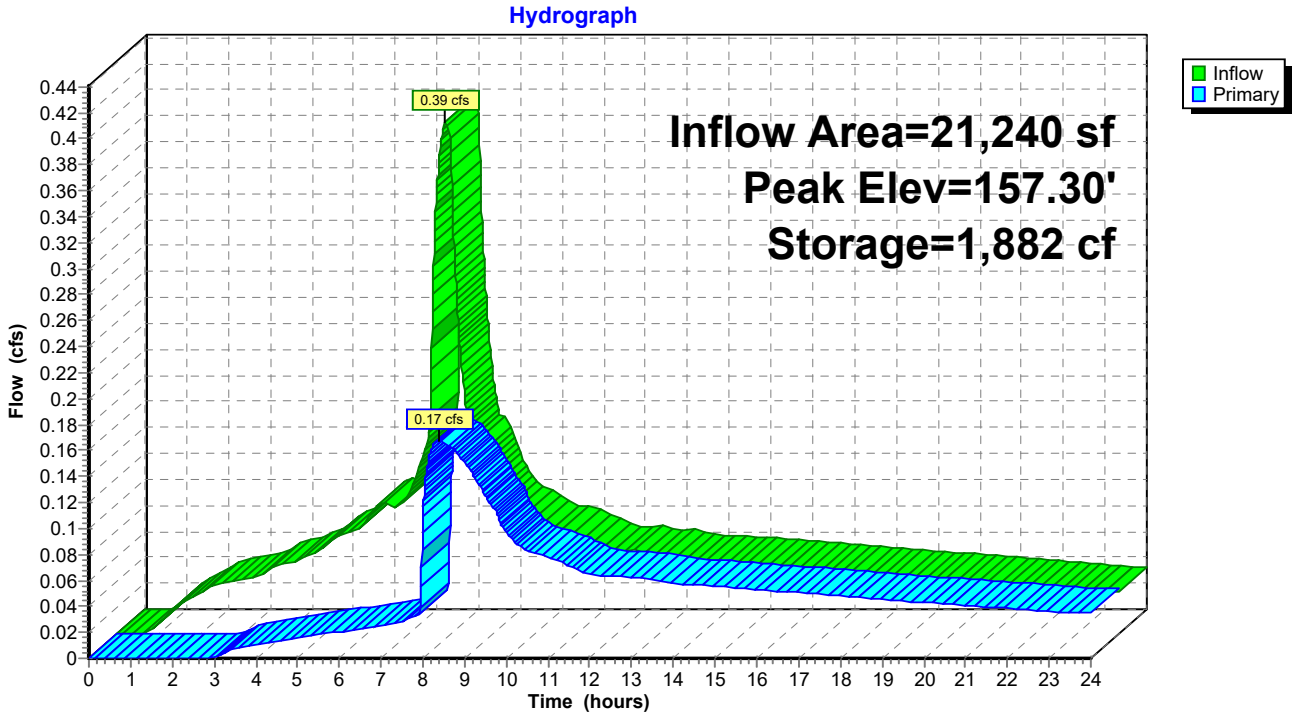
Volume	Invert	Avail.Storage	Storage Description
#1A	154.70'	1,020 cf	**20.50'W x 53.46'L x 3.50'H Field A** 3,836 cf Overall - 1,286 cf Embedded = 2,549 cf x 40.0% Voids
#2A	155.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 4 Rows of 7 Chambers
		2,306 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	155.20'	**1.0" Horiz. Orifice** C= 0.600 Limited to weir flow at low heads
#2	Device 4	157.00'	**3.0" Horiz. 4.0" Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 4	159.33'	**12.0" Horiz. 12" Orifice** C= 0.600 Limited to weir flow at low heads
#4	Primary	155.20'	**8.0" Round Culvert** L= 147.3' Ke= 0.500 Inlet / Outlet Invert= 155.20' / 153.84' S= 0.0092 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.17 cfs @ 8.39 hrs HW=157.30' (Free Discharge)
└**4=Culvert** (Passes 0.17 cfs of 1.52 cfs potential flow)
  ├**1=Orifice** (Orifice Controls 0.04 cfs @ 6.98 fps)
  ├**2=4.0" Orifice** (Orifice Controls 0.13 cfs @ 2.64 fps)
  └**3=12" Orifice** (Controls 0.00 cfs)

Pond 1P: Detention Pipe & Flow Control Manhole



Summary for Subcatchment 1S: Post-Developed Site Area Detained

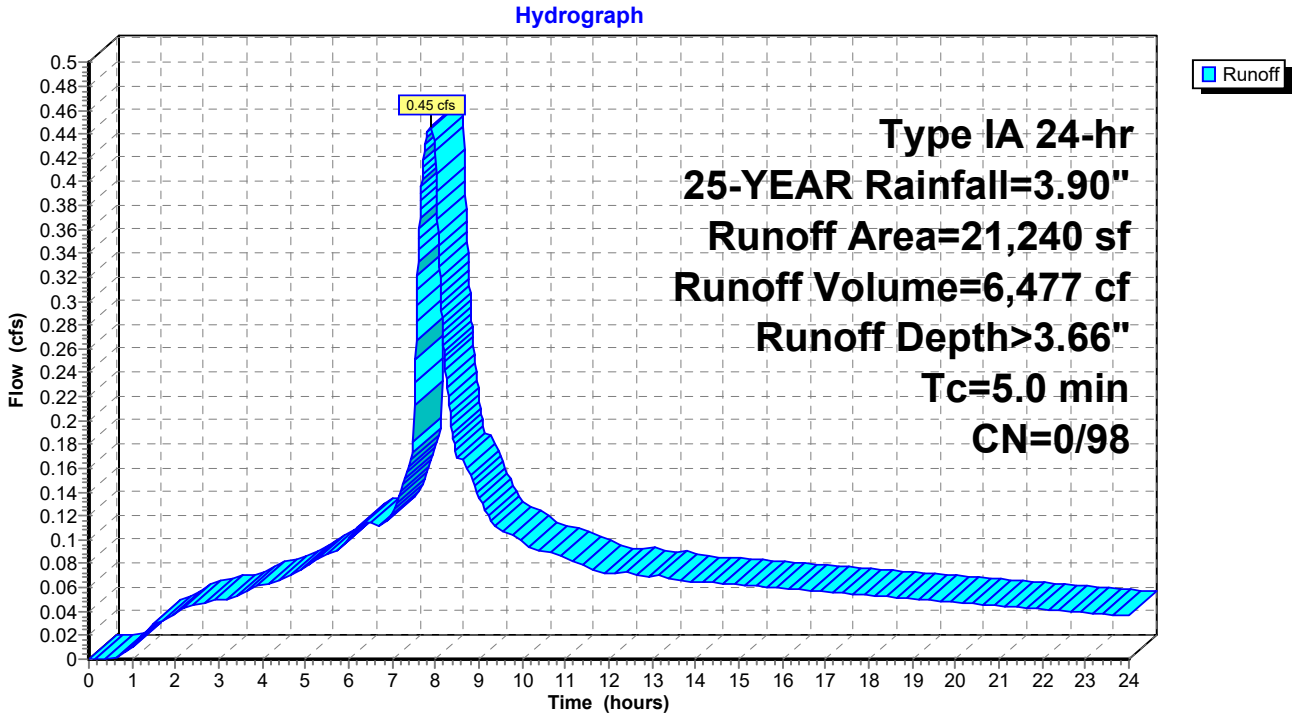
Runoff = 0.45 cfs @ 7.88 hrs, Volume= 6,477 cf, Depth> 3.66"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-YEAR Rainfall=3.90"

	Area (sf)	CN	Description
*	21,240	98	Gravel Area
	21,240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Post-Developed Site Area Detained



Summary for Subcatchment 3S: Post-Developed Site Area Undetained

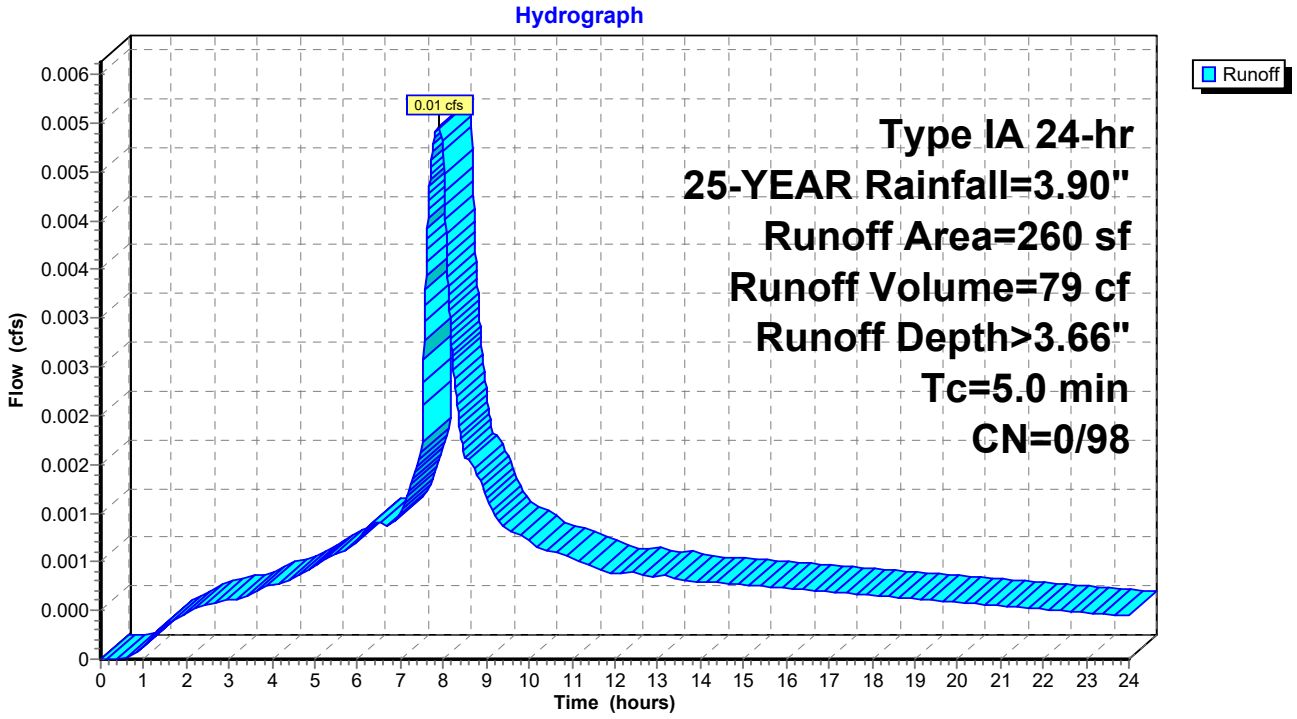
Runoff = 0.01 cfs @ 7.88 hrs, Volume= 79 cf, Depth> 3.66"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-YEAR Rainfall=3.90"

	Area (sf)	CN	Description
*	260	98	Gravel Area
	260		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: Post-Developed Site Area Undetained



Summary for Pond 1P: Detention Pipe & Flow Control Manhole

Inflow Area = 21,240 sf,100.00% Impervious, Inflow Depth > 3.66" for 25-YEAR event
Inflow = 0.45 cfs @ 7.88 hrs, Volume= 6,477 cf
Outflow = 0.22 cfs @ 8.29 hrs, Volume= 4,786 cf, Atten= 50%, Lag= 24.7 min
Primary = 0.22 cfs @ 8.29 hrs, Volume= 4,786 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 157.59' @ 8.29 hrs Surf.Area= 1,096 sf Storage= 2,038 cf

Plug-Flow detention time= 294.7 min calculated for 4,786 cf (74% of inflow)
Center-of-Mass det. time= 127.6 min (786.4 - 658.8)

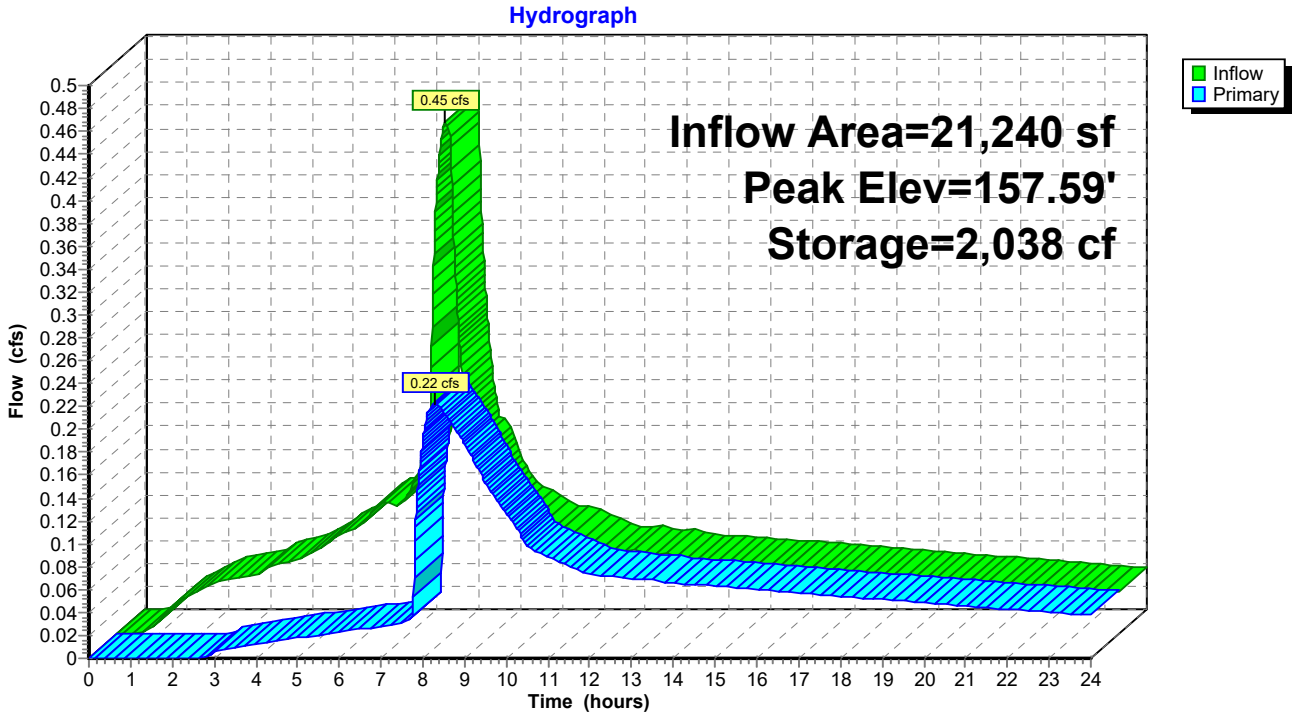
Volume	Invert	Avail.Storage	Storage Description
#1A	154.70'	1,020 cf	**20.50'W x 53.46'L x 3.50'H Field A** 3,836 cf Overall - 1,286 cf Embedded = 2,549 cf x 40.0% Voids
#2A	155.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 4 Rows of 7 Chambers
		2,306 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	155.20'	**1.0" Horiz. Orifice** C= 0.600 Limited to weir flow at low heads
#2	Device 4	157.00'	**3.0" Horiz. 4.0" Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 4	159.33'	**12.0" Horiz. 12" Orifice** C= 0.600 Limited to weir flow at low heads
#4	Primary	155.20'	**8.0" Round Culvert** L= 147.3' Ke= 0.500 Inlet / Outlet Invert= 155.20' / 153.84' S= 0.0092 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf

Primary OutFlow Max=0.22 cfs @ 8.29 hrs HW=157.59' (Free Discharge)
└**4=Culvert** (Passes 0.22 cfs of 1.60 cfs potential flow)
  ├**1=Orifice** (Orifice Controls 0.04 cfs @ 7.45 fps)
  ├**2=4.0" Orifice** (Orifice Controls 0.18 cfs @ 3.70 fps)
  └**3=12" Orifice** (Controls 0.00 cfs)

Pond 1P: Detention Pipe & Flow Control Manhole



Appendix D: Water Quality Facility Calculations and Details

PRAXAIR EQUIPMENT YARD
WATER QUALITY CALCULATIONS

Project:	Praxair Equipment Yard
AKS Job No.:	7784
Date:	March 26, 2021
Done By:	TMI
Checked By:	CEG

IMPERVIOUS AREA

Total Impervious Area: 21,240 sf

WATER QUALITY VOLUME (WQV)

(Per CWS 4.08.5a - R&O 19-22)

$$WQV = \frac{0.36\text{" X Area (ft)}}{12\text{" per ft}} = \mathbf{637}\ \textbf{cubic feet}$$

WATER QUALITY FLOW (WQF)

(Per CWS 4.08.5a - R&O 19-22)

$$WQF = \frac{WQV\ (sf)}{4*60*60} = \mathbf{0.04}\ \textbf{cfs}$$

WATER QUALITY FLOW (WQF)

(Per CWS 4.08.5a - R&O 19-22)

$N=Q_{treat}\,(449_{gpm/cfs} / Q_{cart\ gpm/cart})$ $N=Q_{treat}\,(449_{gpm/cfs} / 15.0_{cart\ gpm/cart})$

N= 1.32 cart 2 SINGLE CARTRIDGE STORMFILTER

Appendix E: USDA-NRCS Soil Resource Report

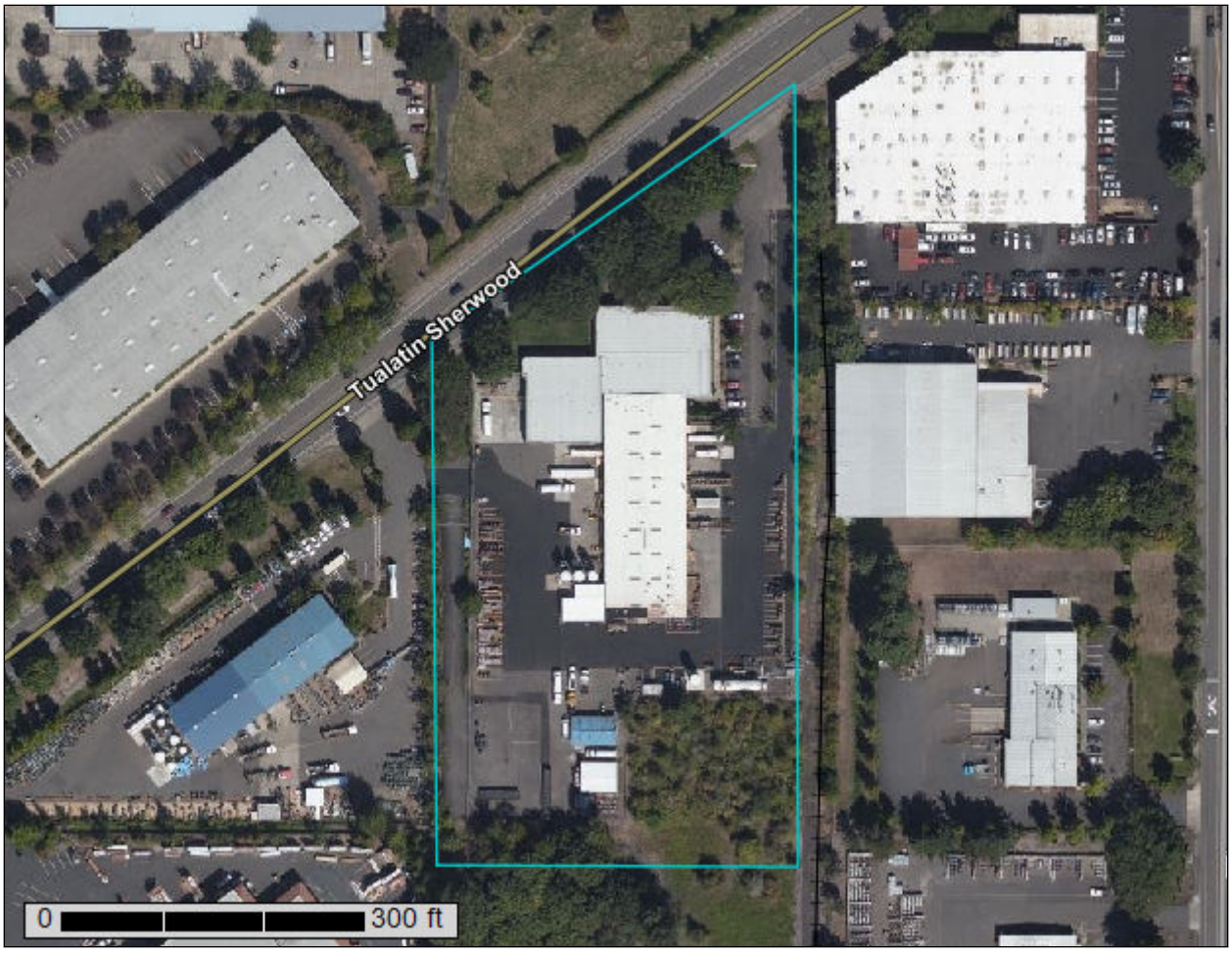
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Washington County, Oregon



October 13, 2020

Contents

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,370 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 18, Jun 11, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 1, 2019—Sep 12, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
2	Amity silt loam	1.2	22.5%
45A	Woodburn silt loam, 0 to 3 percent slopes	3.2	60.5%
45B	Woodburn silt loam, 3 to 7 percent slopes	0.9	17.0%
Totals for Area of Interest		**5.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The

delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Washington County, Oregon														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
2—Amity silt loam														
Amity	85	C/D	0-12	Silt loam	ML	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	90-93-95	30-35-40	5-8 -10
			12-40	Silty clay loam	CL	A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	95-98-100	40-43-45	15-18-20
			40-60	Silt loam	ML	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	90-93-95	30-35-40	5-8 -10
45A—Woodburn silt loam, 0 to 3 percent slopes														
Woodburn	85	C	0-16	Silt loam	ML	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-90-95	70-78-85	25-28-30	NP-3 -5
			16-31	Silty clay loam, silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	85-90-95	30-35-40	10-15-20
			31-60	Silty clay loam, silt loam	ML, CL, CL-ML	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	80-85-90	25-30-35	5-8 -10
45B—Woodburn silt loam, 3 to 7 percent slopes														
Woodburn	85	C	0-16	Silt loam	ML	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-90-95	70-78-85	25-28-30	NP-3 -5
			16-31	Silty clay loam, silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	85-90-95	30-35-40	10-15-20
			31-60	Silt loam, silty clay loam	CL-ML, ML, CL	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	80-85-90	25-30-35	5-8 -10

Appendix F: TR55 Runoff Curve Numbers

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2/]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.